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Agricultural treatment method of oil sludge

Long Wenyu, Shao Luhua, Zou Linlin
Liaoning Shihua University No.1 west Dandong Rd., Fushun City, Liaoning Province, China 113001

Abstract:- Oily sludge can be divided into sludge from oil tank, scum mud and landing mud. The sludge composition is so complex because of containing hydrocarbons, benzene, phenol, anthracene and other substances with the odor and toxicity. It's generally made up of the oil in water, water in oil and suspended solids. The resource utilization and harmlessness of solid waste is the important content for the construction of saving society. In this paper, the research status and development of oil sludge agricultural treatment technology were reviewed including composting method, land-farming method and phytoremediation method. All these methods were compared and commented before the future research suggestion were presented.

Keywords: Oily sludge, Compost method, Oil removal rate, Harmless.

I. INTRODUCTION

Oily sludge is a kind of oily solid waste in the process of oil transportation, exploitation, refining, and oily wastewater treatment, and it is colloid system composed of petroleum hydrocarbons, colloid, asphaltene, sand, inorganic flocs, organic flocs, water and so on. Oily sludge contains hundreds of toxic compounds in which some as benzene, polycyclic aromatic hydrocarbons are carcinogenesis, teratogenesis and mutagenicity. According to Chinese current 16×10^8 t a^{-1}crude oil yield, there will be nearly one million tons oil sludge per year. Harmless, reduction, resource treatment processing of oily sludge have attract more attentions, such as demulsification method, profile control method, flotation method, solidify method, chemical cleaning method, burning method, extraction method, pyrolysis method, biological method and so on. And the agricultural treatment is one of them which is more environmental.

II. COMPOST METHOD

Compost method is a treatment method of oily sludge that oily sludge added artificial enhanced microorganism mixes with appropriate nourishment to stack.

At present, Institute of Soil Science, Chinese Academy of Sciences [1] has done much research. The lab experiment is as follows. Oily sludge, 5 cm rice straw (conditioner), water and dried pig manure (organic fertilizer) were experimental materials. The proportion of Carbon, Nitrogen and Phosphate of dried pig manure was 24:1:1, available nitrogen content of dried pig manure was 2-2.5% and moisture content was 50%. In this paper, sludge (wet weight), rice straw and dried pig manure mixed in proportion of 100:2.02:4.5 by shovel, and they were put into plastic bucket (high 1m, bottom diameters 0.65, upside diameters 0.55m). Then PVC film covered bucket to keep suitable temperature and humidity, ventilation pipe horizontally inserted the middle section of bucket. Specially, the ventilation pipe drilled Φ0.5cm pore covered with nylon mesh every 10 cm to avoid leaking. After thirty days of fermentation, more organic fertilizers needed to be added on 31st day.

The results showed that after fermentation water content was maintained at 40%-60%. It was deduced that compost improve the structure of oily sludge ,such as loose porous and good air permeability, which was conducive to form granular sludge to keep water. After sludge compost EC50 values increased from 1.77 ± 0.28 $mg\cdot ml^{-1}$ to 2.76 ± 0.38 $mg\cdot ml^{-1}$, which showed that the sludge biological toxicity ($p<0.01$) significantly decreased.

School of Agricultural Technology in Greece [2] improved the traditional composting process on oily sludge. They mixed oily sludge with shredded green wastes and designed two tests (R1, R2). In the R1 experiment, the ratio of oil refinery sludge (ORS) and shredded green wastes (GW) was 1:1 (v/v). In the R2 experiment, the ratio of oil refinery sludge (ORS) and shredded green wastes (GW) was 1:3 (v/v). The CO_2, CH_4 emissions and oil removal rate in R1 and R2 were monitored at regular time. The results showed that the total emission of CO_2 and CH_4 was 57.2 mg/kg (dry weight) in R1, and the total emission of CO_2 and CH_4 was 34.3 mg/kg (dry weight) in R2. The oil removal rates respectively were 52.1% and 62.1% in R1 and R2. Arak University of Medical Sciences in Iran [3] improved the traditional composting process on oily sludge. Chemical oxidation was carried out in compost. A certain amount of H_2O_2 was added every 24h and a certain amount of Fenton was added every 24h. The results showed that the ratio of the sludge and immature compost was 1:8 and petroleum hydrocarbons removal rate was 80.2%.

In a word, Oily sludge compost method is applicable to the treatment of high hydrocarbon oily sludge, operation is simple, easy maintenance and low cost.

III. LAND-FARMING METHOD

Land-farming method is the treatment method of oily sludge that petroleum hydrocarbon into oily sludge is transformed into the harmless composition in soil through the metabolism of microorganism in the natural environment.

At present, Chinese Research Academy of Environmental Sciences [4] has done much research and the lab experiment is as follows. There were three test areas and one natural attenuation control area (2.3m ×1.5m× 0.4m) in the peat bioremediation aging sludge test where the mass ratio of oily sludge and peat was 1:1. Test area needed deep plowing one times per month. Then in the 1st, 2ed, 4th, 9th, 13th, 16th and 26th months of the repair, sampling analysis of each test area was performed through the method of mixed multi-point sampling and each composite sample consisted of 10 sample points. The samples were preserved at 4 ℃. The results showed that the peat could significantly improve the bioremediation effect of aging oil sludge and the degradation rate of total petroleum hydrocarbons (TPH) in aging oil was 38.9%. The method obviously improved physicochemical properties of aging oil sludge such as salt concentration decreasing significantly (pH from 8.7 to 6.9, total salt content reducing from 20.3g/kg to 7.3g/kg), the concentration of organic matter increasing and available N P K concentration increasing significantly, which improved the amount of microorganism and biological diversity. Texas A&M University in USA [16] researched the dosing ratio of C, N, P and K in land-farming process. The results showed that when C: N: P: K was 1:2:4:1, the degradation efficiency was up to 63%. Laboratory Microbial Ecology in Belgium [17] performed a large-scale land-farming experiment after studying characterization of the oil sludge. The results showed that during the first 12 months, the hydrocarbon (HC) was degraded at a rate of 15g HC/kg dry soil per year. The next 40 months the degradation rate was about 4gHC/kg dry soil per year, besides the microbial activity reduced from approximately 0.060 to 0.005g CO_2-C/kg dry soil per day.

Table 1. The characterization of oily sludge.

Parameter	Value (%)
Moisture content	32
Ash content	10
Chloroform extractable HC Silica gel ractionation	44
Saturated	36
Aromatic	51
Asphaltic	13

Department of Microbiology, Agricultural University of Norway in Norway [18] performed biodegradation experiment of oily sludge in Norwegian soils, the results showed that the optimum temperature for oil degradation was about 18°C. The degradation efficiency was 83%.

IV. PHYTOREMEDIATION METHOD

Phytoremediation method is a new oily sludge treatment method in which plant cooperates with bacterium. In the process, oily sludge holding water rate increases, toxicity decreases and biological diversity improves.

At present, China University of Petroleum [19] has done much research. The lab experiment is as follows. By indoor potted method, the lab experiment studied the effect of tall fescue on hydrocarbon degradation and determined hydrocarbon degradation rate, quantity of soil microorganisms, fluorescein diacetate activity, catalase activity and dehydrogenase activity. The results showed that compared with non-rhizosphere soil, total petroleum hydrocarbons disappeared faster in the rhizosphere soil system. After 10 weeks, the total petroleum hydrocarbon degradation rates of non-rhizosphere and rhizosphere soil were 11.8% and 27.4%. Compared with no–grass-system, planting tall fescues system significantly increased the first-order rate constant of petroleum hydrocarbon degradation. Key Laboratory of Soil Environment and Pollution Remediation of Chinese Academy of Sciences [20] treated the oily sludge by Phytoremediation method. In the process, Rhizosphere bacteria (Pseudomonas sp. SB) would assist tall fescue to treat the oily sludge soil contaminated. The results showed that in tall fescue+SB treatments，the content of total petroleum hydrocarbon in soil decreased by 84.5% after 120 d, moreover the content of polycyclic aromatic hydrocarbons (PAHs) decreased by 46.2 %. Nanjing Forestry University [21] has researched on Phytoremediation method, and five kinds of plants were involved, including Soybean, alfalfa, corn, sorghum and tall fescue. The result was shown in table 2. Moreover Tall fescue rhizosphere bacteria had growth-promoting effect on tall fescue seed. The strains with ACC deaminase activity could enhance the salt tolerance of tall fescue.

Table 2. The degradation rate of different plant

Plant	Degradation rate/%
Soybean	34.2
alfalfa	28.5
corn	26.6
sorghum	23.1
tall fescue	20.1

Phytoremediation has its limitations. The plant tolerance to pollutants or accumulation is different and some plants can only repair some pollutants. However, components of organic pollutants in soil are complex, which often affects the efficiency of phytoremediation. Phytoremediation has disadvantages of long cycle and slow procedure, moreover it must meet the essential conditions for plant growth. The requirements on soil fertility, moisture, texture, salinity, pH and climate condition are high. The effect of phytoremediation is easily affected by natural factors such as plant diseases and insect pests, flood and so on. Also, the improper disposal of plant harvest part will lead to a secondary pollution to a certain extent. Therefore, whether the plant growth-promoting rhizobacteria are used to solve problems that plants encounter in the repair process will become a great key problem of the joint repair between plant and microbe.

V. CONCLUSION

With the rapid development of petrochemical industry, how to handle reasonably oily sludge has became a bottleneck for the development of enterprises. The harmless treatment of oily sludge will be the development direction of research. Agricultural method is one promising technology in harmless treatment technology.

REFERENCE

[1]. D. M. Yu, Y. M. Luo and W. X. Liu, et al, *Acta Pedologica Sinica*, **6**, 46(2009).
[2]. M. S. Fountoulakis, S. Terzakis, E. Georgaki, et al, *Biodegradation*, **13**, 20(2009).
[3]. A. Koolivand, K. Naddafi, R. Nabizadeh, et al, *J Mater Cycles Waste Manag*, **7**, 5(2013).
[4]. G. L. Lu, S. J. Wang, G. L. Guo, et al, *Journal of Environmental Engineering*, **7**, 05(2011).
[5]. K. W. Brown, K. C. Donnelly and L. E. Deuel Jr, *Microb Eco*, **11**, 9(1983).
[6]. G. Genouw, F. de Naeyer, p. van Meenen, *Biodegradation*, **10**, 5((1994).
[7]. S. Sandvik, A. Lode and T. A. Pedersen, *Appl Microbiol Biotechnol*, **5**, 23(1986).
[8]. M. Lu, Z. Z. Zhang, S. S. Sun**,** et al, *environmental science*, **7**, 30(2009).
[9]. W. X. Liu, Y. M. Luo, Y. Teng, et al, *Environ Geochem Health*, **7**, 32(2010).
[10]. D. X. Wang, master thesis, *Nanjing Forestry University*, (2010).